Static magnetic order and anisotropy of the layered cobalt dioxides $\text{Bi}_{1.6}\text{Pb}_{0.4}\text{Sr}_2\text{Co}_2\text{O}_y$ and $\text{Bi}_2\text{Sr}_2\text{Co}_2\text{O}_y$

J. Sugiyama\textsuperscript{1}, Y. Ikedo\textsuperscript{1}, H. Nozaki\textsuperscript{1}, P. L. Russo\textsuperscript{2}, J. H. Brewer\textsuperscript{2,3}, E. J. Ansaldo\textsuperscript{2}, G. D. Morris\textsuperscript{2}, K. H. Chow\textsuperscript{4}, D. Andreica\textsuperscript{5}, A. Amato\textsuperscript{6}, T. Fujii\textsuperscript{7}, S. Okada\textsuperscript{8}, and I. Terasaki\textsuperscript{8}

\textsuperscript{1}Toyota Central Research and Development Labs. Inc., Nagakute, Aichi 480-1192, Japan
\textsuperscript{2}TRIUMF, 4004 Wesbrook Mall, Vancouver, BC, V6T 2A3 Canada
\textsuperscript{3}CIFAR and Department of Physics and Astronomy, University of British Columbia, Vancouver, BC, V6T 1Z1 Canada
\textsuperscript{4}Department of Physics, University of Alberta, Edmonton, AB, T6G 2G7 Canada
\textsuperscript{5}Faculty of Physics, Babes-Bolyai University, 3400 Cluj-Napoca, Romania
\textsuperscript{6}Lab. for Muon-Spin Spectroscopy, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland
\textsuperscript{7}Cryogenic Center, University of Tokyo, 2-11-16 Yayoi, Bunkyo-ku, Tokyo 113-0032, Japan
\textsuperscript{8}Department of Applied Physics, Waseda University, Tokyo 169-8555, Japan

The magnetism of a Pb-doped Bi$_2$Sr$_2$Co$_2$O$_y$ (BSCO) crystal has been investigated by $\mu$+SR spectroscopy. Weak transverse-field (wTF-) $\mu$+SR measurements show that the whole sample enters into a magnetic state below ~4.5 K. Combining the results of zero-field (ZF-) $\mu$+SR experiment with susceptibility measurements, it is clarified that the sample is in a ferromagnetic ordered phase with a Curie temperature ($T_C$) of 4.7 K and with the ordered internal magnetic field almost parallel to the $c$-axis. On the other hand, a pure BSCO crystal is also found to exhibit a bulk magnetic transition at 1.0 K by $\mu$+SR. Since the relationship between the reduced transition temperature and reduced internal magnetic filed for BSCO is almost equivalent to that for Pb-doped BSCO, the origin of the magnetic transition for both crystals is thought to be explained by common physics.

Although both wTF- and ZF- measurements confirm the absence of static magnetic order above $T_C$ for both crystals, weak longitudinal-field measurements indicate the existence of a local maximum around 60 K ($=T_A$) in the temperature dependence of the relaxation rate, implying the increase in magnetic inhomogeneity towards $T_A$. This suggests an essential role of magnetic fluctuations on the metal-to-insulator-transition around 60 K [1], which is seen in the $T$ dependence of resistivity for Pb-doped BSCO and BSCO [2].